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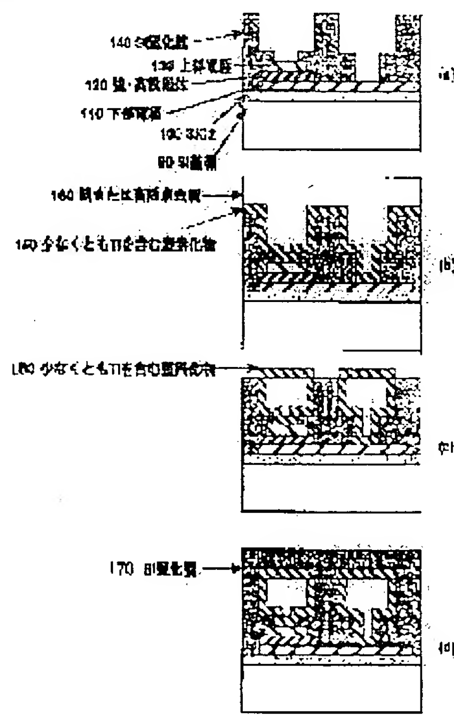
(54) SEMICONDUCTOR DEVICE AND FORMING METHOD THEREOF

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a semiconductor device and a forming method thereof, wherein copper or high-melting metal is used as a wiring material, and a wiring is capable of recovering from deterioration through a high-temperature thermal treatment, after it has been formed.
SOLUTION: Wirings connected to electrodes 110 and 130 of a capacitor, where a ferroelectric thin film or high-dielectric thin film 120 is used, are formed of a copper or a material whole main component is a high-melting metal 160, and a Ti-containing nitride 150 is provided around the wirings to cover, and the capacitor and the wirings are covered with an Si nitride 170. Furthermore, a wiring connected to the ferroelectric thin film or high-dielectric thin film 120 is formed, and then a thermal treatment is carried out at least once in an atmosphere of nitrogen or inert gas or in a vacuum.



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CLAIMS

[Claim(s)]
[Claim 1] The semiconductor device characterized by wiring linked to the electrode of capacity using a ferroelectric thin film or a high dielectric thin film consisting of an ingredient which uses copper or a refractory metal as a principal component in a semiconductor device, and it being covered with the nitride with which the perimeter of this wiring contains Ti at least, and coming to cover said capacity and wiring with Si nitride.
[Claim 2] The semi-conductor ****** approach which this semiconductor device is a semiconductor device according to claim 1, and is characterized by giving a heat treatment process once [at least] in the approach of forming a semiconductor device after forming wiring linked to said ferroelectric thin film or a high dielectric thin film.
[Claim 3] The semiconductor device formation approach according to claim 2 which the wiring material linked to the ferroelectric thin film or high dielectric thin film of said semiconductor device is copper, and is characterized by giving the process which performs said heat treatment in nitrogen, an inert gas ambient atmosphere, or a vacuum.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates especially to the stabilizing treatment about the semiconductor device which has a component using the ferroelectric or high dielectric which is a kind of a semiconductor device, and its formation approach.
[0002]
[Description of the Prior Art] The capacity using a conventional ferroelectric thin film or a conventional high dielectric thin film On a substrate, use IrO2, RuO2 and CoO (LaxSr 1-x)3 of Pt of noble metals, Au, or an oxide conductor, YBa2Cu3Ox, etc., and a lower electrode is formed. subsequently, organic metal decomposition (MOD:Metal OrganicDecomposition) -- law -- Law etc. is used. a spatter and organic metal chemical vapor deposition (MO-CVD:Metal Organic Chemical Vapor Deposition) -- An up electrode is mainly formed using the same ingredient as a lower electrode after forming the ferroelectric thin film of Pb(Zr, Ti) O3 system or 2OSrBi2(Ta, Nb) 9 system.
[0003] Then, by the technique usually used by semiconductor industry, an insulating thin film, for example, Si oxide film, and Si nitride are deposited, the contact hole to an electrode is formed, and wiring (aluminum wiring) which uses aluminum as a principal component is formed.
[0004] The substrate of aluminum wiring has many examples which insert conductive thin films, such as TiN and W, for the purpose, such as raising the contact engine performance between a transistor and aluminum wiring, or raising adhesion with an electrode.
[0005]
[Problem(s) to be Solved by the Invention] The electrical property of these ferroelectrics or high dielectric capacity deteriorates in various phases in process. Usually, the effect of the plasma damage in the semi-conductor manufacture selective etching used or the stress change between processes caused this degradation. However, generally such degradation is recoverable by performing 500-800-degree C heat treatment (recovery heat processing) in an oxygen ambient atmosphere.
[0006] However, since the melting point of a problem of aluminum is low, it is being unable to perform hot recovery heat processing after aluminum wiring processing. Below, although a ferroelectric is explained, it is completely the same also about a high dielectric.
[0007] this invention person created the sample which has structure as shown in drawing 1 , and considered degradation of the ferroelectric property after aluminum wiring formation. And degradation by aluminum wiring formation examined especially paying attention to over etching, while happening at various processes, such as sputter deposition of aluminum, etching, aluminum over etching, and resist removal.
[0008] After the sample processed it by having carried out the sequential deposition of Ti and the Pt and formed the Pt/Ti30 lower electrode on the Si oxide film 20 first, it carried out the sequential

deposition of SrBi2Ta 2O940 and Pt50, processed the up electrode / ferroelectric, after creating capacity, it deposited SiO260, formed the contact hole, deposited and processed aluminum, and formed the aluminum wiring 70.
[0009] The I-V property after processing which processed aluminum wiring at over etching 60% using Cl2 is shown in drawing 2 . Over etching is etching further performed in order to remove the residue of aluminum completely after it becomes impossible to detect aluminum chloride which is carrying out the monitor during etching, and the percentage to time amount until aluminum chloride is no longer detected here shows.
[0010] Drawing 2 (a) is the wafer periphery section, and drawing 2 (b) shows the I-V property of the capacity of a wafer center section. In the periphery section, degradation is hardly seen to a thing with degradation intense in the center section. Then, since processing advanced from a wafer center section as a result of investigating the field internal division cloth of the working speed in this equipment, as for the center section, the ******** turned [over etching time amount] out to see in a wafer side from the periphery.
[0011] Moreover, the I-V property of the capacity of the wafer periphery section when changing over etching with 30 and 60 or 75%, and processing aluminum wiring is shown in drawing 3 (a) - (c). Degradation is increasing in connection with over etching increasing. Moreover, degradation at the time of aluminum wiring processing is so remarkable that over etching is long so that drawing 2 and drawing 3 may show, and to reduce this over etching is desired.
[0012] however -- although there is some difference in the etching engine performance by equipment -- what kind of equipment -- be -- in order to cover dispersion in the working speed by field internal division cloth, a micro loading effect, etc. of aluminum thickness, about several 10% of over etching must be performed.
[0013] Furthermore, although the over etching of aluminum became clear [that it is the main factor of degradation] by this trial, as stated previously, degradation by other factors, such as sputter deposition of aluminum wiring and resist removal, is also considered that it cannot still ignore. Degradation is produced, also when it is very short and over etching is actually processed as 30%. It turns out that it is very difficult to avoid degradation at aluminum wiring process as mentioned above.
[0014] Therefore, although it needs to be processed for a certain recovery, hot recovery heat processing cannot be performed to aluminum wiring. Although 500-800 degrees C is required for recovery, since the melting point is 660 degrees C, at such an elevated temperature, the reflow of aluminum, condensation, diffusion, etc. arise and aluminum which is the principal component of aluminum wiring causes the short-circuit between the increment in resistance, an open circuit, and wiring etc. Although this invention person tried recovery by heat treatment at 400 degrees C in oxygen or nitrogen-gas-atmosphere mind, what (refer to drawing 4) recovery is not seen for was understood.
[0015] Although the electrical property of a ferroelectric or high dielectric capacity deteriorates in various phases in process, the effect of the plasma damage in the semi-conductor manufacture selective etching usually used, the stress change between processes, etc. causes this degradation. It is very difficult for degradation to arise similarly in aluminum wiring formation process, and to avoid this according to process conditions etc.
[0016] After aluminum wiring processing, although this process degradation is generally recoverable by performing 500-800-degree C heat treatment (recovery heat processing) in a **** ambient atmosphere, since the melting point of aluminum is low, hot recovery heat processing cannot be performed but there is no restorative means.
[0017] The place which this invention is made in view of the above, and is made into the purpose uses copper or a refractory metal for a wiring material, and is to offer the semiconductor device which can

recover degradation after wiring formation by elevated-temperature heat treatment, and its formation approach.

[0018]

[Means for Solving the Problem] The above-mentioned technical problem and purpose are solved and attained by this invention shown below. That is, this invention indicates the semiconductor device characterized by wiring linked to the electrode of capacity using a ferroelectric thin film or a high dielectric thin film consisting of an ingredient which uses copper or a refractory metal as a principal component, and it being covered with the nitride with which the perimeter of this wiring contains Ti at least, and coming to cover said capacity and wiring with Si nitride in a semiconductor device.

[0019] Moreover, this invention is the semiconductor device of the above [this semiconductor device] in the approach of forming a semiconductor device. And after forming wiring linked to said ferroelectric thin film or a high dielectric thin film, The semi-conductor ****** approach characterized by giving a heat treatment process once [at least], And the semiconductor device formation approach which the wiring material linked to the ferroelectric thin film or high dielectric thin film of said semiconductor device is copper, and is characterized by giving the process which performs said heat treatment in nitrogen, an inert gas ambient atmosphere, or a vacuum is indicated.

[0020] The semiconductor device of this invention is characterized by being covered with the nitride with which the perimeter of this wiring contains Ti in wiring linked to the electrode of the capacity which used the ferroelectric thin film or the high dielectric thin film at least using the ingredient which uses copper or a refractory metal as a principal component, and covering this wiring and capacity with Si nitride.

[0021] After the semiconductor device formation approach of this invention forms wiring linked to the aforementioned ferroelectric thin film or aforementioned high dielectric thin film of a semiconductor device, it is characterized by heat-treating once [at least].

[0022] Moreover, when the wiring material linked to the aforementioned ferroelectric thin film or aforementioned high dielectric thin film of a semiconductor device is copper, it is characterized by performing the aforementioned heat treatment in nitrogen, an inert gas ambient atmosphere, or a vacuum.

[0023] The melting point of copper and a refractory metal is 1000 degrees C or more, therefore can perform 500-800-degree C heat treatment required for recovery of a ferroelectric. Although peeling and diffusion pose a problem when heat-treating using those wiring materials, it can prevent by using the nitride which contains Ti at least.

[0024] Moreover, although oxidation may arise when a wiring material covers with Si oxide film like copper **** and before, it is avoidable by using Si nitride. Furthermore, a ferroelectric property is recoverable, preventing oxidation of wiring by reducing the oxygen tension in an ambient atmosphere by making the ambient atmosphere at the time of heat treatment into the inside of inactive or a vacuum.

[0025]

[Embodiment of the Invention] Hereafter, the embodiment of this invention is explained to a detail with reference to a drawing. As shown in drawing 5 , right above [up electrode] carries out opening of the gestalt of the best operation of this invention to the capacity which consisted of the Si oxide film 100, a lower electrode 110, a ferroelectric thin film 120, and an up electrode 130 on the Si substrate 90, and the Si nitride 140 in which the wiring gutter was formed is formed (refer to drawing 5 (a)).

[0026] In opening and the wiring gutter of this Si nitride, the wiring 160 which uses as a principal component the nitride 150, the copper, or the refractory metal which contains Ti at least is embedded by the reflow spatter, CVD, etc. one by one (refer to drawing 5 (b)). The nitride with which the Si

nitride 170 is deposited and the circumference of wiring 160 contains Ti at least, and structure by which sequential covering was carried out by Si nitride are created by removing the wiring material deposited out of the slot by technique, such as etchback and CMP (Chemical Mechanical Polishing), and depositing and processing the nitride 150 which contains Ti at least (referring to drawing 5 (c)) (refer to drawing 5 (d)).

[0027] Although the above-mentioned wiring is formed by the damascene method, wiring may be formed by the technique of being different if the wiring 160 which uses copper or a refractory metal as a principal component with the compound 150 which contains Ti at least is formed.

[0028] The I-V property of a ferroelectric is completely recovered by performing 500-800-degree C heat treatment after wiring formation. When wiring is copper, the I-V property of a ferroelectric is completely recovered by heat-treating in nitrogen, an inert gas ambient atmosphere, or a vacuum.

[0029] Since the melting point is higher than aluminum, when it is Cu which is 500-800 degrees C when it is a refractory metal, even if a refractory metal and Cu perform recovery heat processing which is 500-700 degrees C, the open circuit by the reflow or condensation does not produce them.

[0030] An adhesion layer and the diffusion prevention film may be further formed around the above-mentioned wiring for the purpose, such as improvement in adhesion force, and diffusion prevention.

[0031] a ferroelectric thin film -- SrBi2(Ta, Nb) 2 -- all the ingredients used for ferroelectric components, such as O9 and O (Zr (Pb, La), Ti), are applicable. Moreover, the same effectiveness is acquired also with the ferroelectric thin film which added or permuted some kinds of other elements by them.

[0032] All (Boro-Phospho-Silicate Glass) of the insulators SiO2, SiN, and SOG (Spin OnGlass) used by the semiconductor device, BPSG, etc. can apply to an insulator substrate.

[0033] Noble metals or an oxide conductor, Pt, Au, IrO2, RuO2, and CoO (La, Sr)3, YBa2Cu3Ox, etc. are applicable to an electrode. [for example,] Moreover, an element can be suitably added to them or the alloy which permuted the element can also be applied to them. For the purpose, such as improvement in adhesion, even if it inserts metal metallurgy group compounds, such as Ti and TiN, suitably, the same effectiveness is acquired.

[0034] The deposition approach of an electrode material or a ferroelectric thin film can apply any depositing methods, such as the MOD method used for semiconductor device creation, a CVD method, and a spatter.

[0035] Processing of capacity and an electrode is realizable by carrying out by milling, RIE (Reactive Ion Etchig), etc. using the photolithography technique usually used by semiconductor industry.

[0036] Below, the embodiment of this invention is explained concretely.

[0037]

[Example] Hereafter, the detail of this invention is explained based on a drawing.

[0038] the 1st example of [example 1] this invention is shown in drawing 5 -- as -- the Si oxide film 100, the lower electrode 110, the ferroelectric thin film 120, and the up electrode 130 -- respectively -- a BPSG substrate, and RuO2 and Pb (Zr, Ti) -- the Si nitride 140 in which opening of right above [up electrode] was carried out to the capacity constituted using O3 and RuO2, and the wiring gutter was formed is formed (refer to drawing 5 (a)).

[0039] To this opening and a wiring gutter, the sequential deposition (refer to drawing 5 (b)) of TiWN150 and the Cu wiring 160 is carried out, polish removal of TiWN outside a wiring gutter and the Cu is carried out by CMP after that, TiWN150 is deposited and processed, and Cu wiring is completely covered with TiWN (refer to drawing 5 (c)). The Si nitride 170 is deposited and Cu wiring is covered with TiN and Si nitride (refer to drawing 5 (d)). It heat-treats in N2 after wiring formation.

[0040] the 2nd example of [example 2] this invention is shown in drawing 5 -- as -- the Si oxide film

100, the lower electrode 110, the ferroelectric thin film 120, and the up electrode 130 -- respectively -- SiO2, Pt, and SrBi2(Ta, Nb) 2 -- the Si nitride 140 in which opening of right above [up electrode] was carried out to the capacity constituted using O9 and Pt, and the wiring gutter was formed is formed (refer to drawing 5 (a)).

[0041] To this opening and a wiring gutter, the sequential deposition (refer to drawing 5 (b)) of TiWN150 and the W wiring 160 is carried out, polish removal of TiWN outside a wiring gutter and the W is carried out by CMP after that, TiWN150 is deposited and processed, and W wiring is completely covered with TiWN (refer to drawing 5 (c)). The Si nitride 170 is deposited and W wiring is covered with TiN and Si nitride (refer to drawing 5 (d)). It heat-treats in a vacuum after wiring formation.

[0042] the 3rd example of [example 3] this invention is shown in drawing 6 -- as -- the Si oxide film 100, the lower electrode 110, the ferroelectric thin film 120, and the up electrode 130 -- respectively -- SiO2 substrate, Pt, and SrBi2(Ta, Nb) 2 -- the Si nitride 140 by which opening of right above [up electrode] was carried out to the capacity constituted using O9 and Pt is formed (refer to drawing 6 (a)). The sequential deposition of TiN150 and the W wiring 160 is carried out on this up electrode, and a wiring configuration is processed (refer to drawing 6 (b)). TiN150 is deposited and processed and W wiring is covered with TiN (refer to drawing 6 (c)).

[0043] It considers as the structure (refer to drawing 6 (d)) where deposited the Si nitride 170 and W wiring was covered with TiN and Si nitride. It heat-treats in O2 after wiring formation.

[0044] As mentioned above, degradation after wiring formation is recoverable by carrying out elevated-temperature heat treatment. That is, although it is because copper or a refractory metal was used for the wiring material, the melting point of copper and a refractory metal is 1000 degrees C or more, therefore it is because 500-800-degree C heat treatment required for recovery of a ferroelectric can be performed. Although peeling and diffusion pose a problem when heat-treating using those wiring materials, it can prevent by using the nitride which contains Ti at least.

[0045] Moreover, if wiring is covered with Si oxide film like before, although oxidation may arise in wiring, it is avoidable by using Si nitride. Degradation after a processing process is recoverable by performing heat treatment after wiring formation. When a wiring material is copper, heat-treating in inactive or a vacuum is desirable. In inactive or a vacuum, since it is few, copper oxidation can be further prevented for oxygen tension.

[0046] Moreover, since the amount of the oxygen which diffuses Si nitride becomes less, even if it makes Si nitride thinner than the case where it is among an oxygen ambient atmosphere, it hardly oxidizes. The specific inductive capacity of ****** can be decreased by thin film-ization of Si nitride, and signal delay can be lessened.

[0047]

[Effect of the Invention] Copper or a refractory metal is used for a wiring material, by carrying out elevated-temperature heat treatment, the outstanding semiconductor device which can recover and stabilize degradation after wiring formation, and its formation approach are offered by this invention, and the effectiveness it is ineffective industry top size is done so.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates especially to the stabilizing treatment about the semiconductor device which has a component using the ferroelectric or high dielectric which is a kind of a semiconductor device, and its formation approach.

[Translation done.]

PRIOR ART

[Description of the Prior Art] Capacity using a conventional ferroelectric thin film or a conventional high dielectric thin film, On a substrate, use IrO_2, RuO_2 and CoO (LaxSr 1-x)3 of Pt of noble metals, Au, or an oxide conductor, $YBa_2Cu_3O_x$, etc., and a lower electrode is formed. subsequently, organic metal decomposition (MOD:Metal OrganicDecomposition) -- law -- Law etc. is used. a spatter and organic metal chemical vapor deposition (MO-CVD:Metal Organic Chemical Vapor Deposition) -- An up electrode is mainly formed using the same ingredient as a lower electrode after forming the ferroelectric thin film of Pb(Zr, Ti) O3 system or 2OSrBi2(Ta, Nb) 9 system.
[0003] Then, by the technique usually used by semiconductor industry, an insulating thin film, for example, Si oxide film, and Si nitride are deposited, the contact hole to an electrode is formed, and wiring (aluminum wiring) which uses aluminum as a principal component is formed.
[0004] The substrate of aluminum wiring has many examples which insert conductive thin films, such as TiN and W, for the purpose, such as raising the contact engine performance between a transistor and aluminum wiring, or raising adhesion with an electrode.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] Copper or a refractory metal is used for a wiring material, by carrying out elevated-temperature heat treatment, the outstanding semiconductor device which can recover and stabilize degradation after wiring formation, and its formation approach are offered by this invention, and the effectiveness it is ineffective industry top size is done so.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] The electrical property of these ferroelectrics or high dielectric capacity deteriorates in various phases in process. Usually, the effect of the plasma damage in the semi-conductor manufacture selective etching used or the stress change between processes caused this degradation. However, generally such degradation is recoverable by performing 500-800-degree C heat treatment (recovery heat processing) in an oxygen ambient atmosphere.
[0006] However, since the melting point of a problem of aluminum is low, it is being unable to perform hot recovery heat processing after aluminum wiring processing. Below, although a ferroelectric is explained, it is completely the same also about a high dielectric.
[0007] this invention person created the sample which has structure as shown in drawing 1 , and considered degradation of the ferroelectric property after aluminum wiring formation. And degradation by aluminum wiring formation examined especially paying attention to over etching, while happening at various processes, such as sputter deposition of aluminum, etching, aluminum over etching, and resist removal.
[0008] After the sample processed it by having carried out the sequential deposition of Ti and the Pt and formed the Pt/Ti30 lower electrode on the Si oxide film 20 first, it carried out the sequential deposition of SrBi2Ta 2O940 and Pt50, processed the up electrode / ferroelectric, after creating capacity, it deposited SiO260, formed the contact hole, deposited and processed aluminum, and formed the aluminum wiring 70.
[0009] The I-V property after processing which processed aluminum wiring at over etching 60% using Cl2 is shown in drawing 2 . Over etching is etching further performed in order to remove the residue of aluminum completely after it becomes impossible to detect aluminum chloride which is carrying out the monitor during etching, and the percentage to time amount until aluminum chloride is no longer detected here shows.
[0010] Drawing 2 (a) is the wafer periphery section, and drawing 2 (b) shows the I-V property of the capacity of a wafer center section. In the periphery section, degradation is hardly seen to a thing with degradation intense in the center section. Then, since processing advanced from a wafer center section as a result of investigating the field internal division cloth of the working speed in this equipment, as for the center section, the ******** turned [over etching time amount] out to see in a wafer side from the periphery.
[0011] Moreover, the I-V property of the capacity of the wafer periphery section when changing over etching with 30 and 60 or 75%, and processing aluminum wiring is shown in drawing 3 (a) - (c). Degradation is increasing in connection with over etching increasing. Moreover, degradation at the time of aluminum wiring processing is so remarkable that over etching is long so that drawing 2 and drawing 3 may show, and to reduce this over etching is desired.
[0012] however -- although there is some difference in the etching engine performance by equipment

-- what kind of equipment -- be -- in order to cover dispersion in the working speed by field internal division cloth, a micro loading effect, etc. of aluminum thickness, about several 10% of over etching must be performed.

[0013] Furthermore, although the over etching of aluminum became clear [that it is the main factor of degradation] by this trial, as stated previously, degradation by other factors, such as sputter deposition of aluminum wiring and resist removal, is also considered that it cannot still ignore. Degradation is produced, also when it is very short and over etching is actually processed as 30%. It turns out that it is very difficult to avoid degradation at aluminum wiring process as mentioned above.

[0014] Therefore, although it needs to be processed for a certain recovery, hot recovery heat processing cannot be performed to aluminum wiring. Although 500-800 degrees C is required for recovery, since the melting point is 660 degrees C, at such an elevated temperature, the reflow of aluminum, condensation, diffusion, etc. arise and aluminum which is the principal component of aluminum wiring causes the short-circuit between the increment in resistance, an open circuit, and wiring etc. Although this invention person tried recovery by heat treatment at 400 degrees C in oxygen or nitrogen-gas-atmosphere mind, what (refer to drawing 4) recovery is not seen for was understood.

[0015] Although the electrical property of a ferroelectric or high dielectric capacity deteriorates in various phases in process, the effect of the plasma damage in the semi-conductor manufacture selective etching usually used, the stress change between processes, etc. causes this degradation. It is very difficult for degradation to arise similarly in aluminum wiring formation process, and to avoid this according to process conditions etc.

[0016] After aluminum wiring processing, although this process degradation is generally recoverable by performing 500-800-degree C heat treatment (recovery heat processing) in a **** ambient atmosphere, since the melting point of aluminum is low, hot recovery heat processing cannot be performed but there is no restorative means.

[0017] The place which this invention is made in view of the above, and is made into the purpose uses copper or a refractory metal for a wiring material, and is to offer the semiconductor device which can recover degradation after wiring formation by elevated-temperature heat treatment, and its formation approach.

[Translation done.]

MEANS

[Means for Solving the Problem] The above-mentioned technical problem and purpose are solved and attained by this invention shown below. That is, this invention indicates the semiconductor device characterized by wiring linked to the electrode of capacity using a ferroelectric thin film or a high dielectric thin film consisting of an ingredient which uses copper or a refractory metal as a principal component, and it being covered with the nitride with which the perimeter of this wiring contains Ti at least, and coming to cover said capacity and wiring with Si nitride in a semiconductor device.
[0019] Moreover, this invention is the semiconductor device of the above [this semiconductor device] in the approach of forming a semiconductor device. And after forming wiring linked to said ferroelectric thin film or a high dielectric thin film, The semi-conductor ****** approach characterized by giving a heat treatment process once [at least], And the semiconductor device formation approach which the wiring material linked to the ferroelectric thin film or high dielectric thin film of said semiconductor device is copper, and is characterized by giving the process which performs said heat treatment in nitrogen, an inert gas ambient atmosphere, or a vacuum is indicated.
[0020] The semiconductor device of this invention is characterized by being covered with the nitride with which the perimeter of this wiring contains Ti in wiring linked to the electrode of the capacity which used the ferroelectric thin film or the high dielectric thin film at least using the ingredient which uses copper or a refractory metal as a principal component, and covering this wiring and capacity with Si nitride.
[0021] After the semiconductor device formation approach of this invention forms wiring linked to the aforementioned ferroelectric thin film or aforementioned high dielectric thin film of a semiconductor device, it is characterized by heat-treating once [at least].
[0022] Moreover, when the wiring material linked to the aforementioned ferroelectric thin film or aforementioned high dielectric thin film of a semiconductor device is copper, it is characterized by performing the aforementioned heat treatment in nitrogen, an inert gas ambient atmosphere, or a vacuum.
[0023] The melting point of copper and a refractory metal is 1000 degrees C or more, therefore can perform 500-800-degree C heat treatment required for recovery of a ferroelectric. Although peeling and diffusion pose a problem when heat-treating using those wiring materials, it can prevent by using the nitride which contains Ti at least.
[0024] Moreover, although oxidation may arise when a wiring material covers with Si oxide film like copper **** and before, it is avoidable by using Si nitride. Furthermore, a ferroelectric property is recoverable, preventing oxidation of wiring by reducing the oxygen tension in an ambient atmosphere by making the ambient atmosphere at the time of heat treatment into the inside of inactive or a vacuum.
[0025]
[Embodiment of the Invention] Hereafter, the embodiment of this invention is explained to a detail

with reference to a drawing. As shown in drawing 5 , right above [up electrode] carries out opening of the gestalt of the best operation of this invention to the capacity which consisted of the Si oxide film 100, a lower electrode 110, a ferroelectric thin film 120, and an up electrode 130 on the Si substrate 90, and the Si nitride 140 in which the wiring gutter was formed is formed (refer to drawing 5 (a)).

[0026] In opening and the wiring gutter of this Si nitride, the wiring 160 which uses as a principal component the nitride 150, the copper, or the refractory metal which contains Ti at least is embedded by the reflow spatter, CVD, etc. one by one (refer to drawing 5 (b)). The nitride with which the Si nitride 170 is deposited and the circumference of wiring 160 contains Ti at least, and structure by which sequential covering was carried out by Si nitride are created by removing the wiring material deposited out of the slot by technique, such as etchback and CMP (Chemical Mechanical Polishing), and depositing and processing the nitride 150 which contains Ti at least (referring to drawing 5 (c)) (refer to drawing 5 (d)).

[0027] Although the above-mentioned wiring is formed by the damascene method, wiring may be formed by the technique of being different if the wiring 160 which uses copper or a refractory metal as a principal component with the compound 150 which contains Ti at least is formed.

[0028] The I-V property of a ferroelectric is completely recovered by performing 500-800-degree C heat treatment after wiring formation. When wiring is copper, the I-V property of a ferroelectric is completely recovered by heat-treating in nitrogen, an inert gas ambient atmosphere, or a vacuum.

[0029] Since the melting point is higher than aluminum, when it is Cu which is 500-800 degrees C when it is a refractory metal, even if a refractory metal and Cu perform recovery heat processing which is 500-700 degrees C, the open circuit by the reflow or condensation does not produce them.

[0030] An adhesion layer and the diffusion prevention film may be further formed around the above-mentioned wiring for the purpose, such as improvement in adhesion force, and diffusion prevention.

[0031] a ferroelectric thin film -- SrBi2(Ta, Nb) 2 -- all the ingredients used for ferroelectric components, such as O9 and O (Zr (Pb, La), Ti), are applicable. Moreover, the same effectiveness is acquired also with the ferroelectric thin film which added or permuted some kinds of other elements by them.

[0032] All (Boro-Phospho-Silicate Glass) of the insulators SiO2, SiN, and SOG (Spin OnGlass) used by the semiconductor device, BPSG, etc. can apply to an insulator substrate.

[0033] Noble metals or an oxide conductor, Pt, Au, IrO2, RuO2, and CoO (La, Sr)3, YBa2Cu3Ox, etc. are applicable to an electrode. [for example,] Moreover, an element can be suitably added to them or the alloy which permuted the element can also be applied to them. For the purpose, such as improvement in adhesion, even if it inserts metal metallurgy group compounds, such as Ti and TiN, suitably, the same effectiveness is acquired.

[0034] The deposition approach of an electrode material or a ferroelectric thin film can apply any depositing methods, such as the MOD method used for semiconductor device creation, a CVD method, and a spatter.

[0035] Processing of capacity and an electrode is realizable by carrying out by milling, RIE (Reactive Ion Etchig), etc. using the photolithography technique usually used by semiconductor industry.

[0036] Below, the embodiment of this invention is explained concretely.

[Translation done.]

EXAMPLE

[Example] Hereafter, the detail of this invention is explained based on a drawing.
[0038] the 1st example of [example 1] this invention is shown in drawing 5 -- as -- the Si oxide film 100, the lower electrode 110, the ferroelectric thin film 120, and the up electrode 130 -- respectively -- a BPSG substrate, and RuO2 and Pb (Zr, Ti) -- the Si nitride 140 in which opening of right above [up electrode] was carried out to the capacity constituted using O3 and RuO2, and the wiring gutter was formed is formed (refer to drawing 5 (a)).
[0039] To this opening and a wiring gutter, the sequential deposition (refer to drawing 5 (b)) of TiWN150 and the Cu wiring 160 is carried out, polish removal of TiWN outside a wiring gutter and the Cu is carried out by CMP after that, TiWN150 is deposited and processed, and Cu wiring is completely covered with TiWN (refer to drawing 5 (c)). The Si nitride 170 is deposited and Cu wiring is covered with TiN and Si nitride (refer to drawing 5 (d)). It heat-treats in N2 after wiring formation.
[0040] the 2nd example of [example 2] this invention is shown in drawing 5 -- as -- the Si oxide film 100, the lower electrode 110, the ferroelectric thin film 120, and the up electrode 130 -- respectively -- SiO2, Pt, and SrBi2(Ta, Nb) 2 -- the Si nitride 140 in which opening of right above [up electrode] was carried out to the capacity constituted using O9 and Pt, and the wiring gutter was formed is formed (refer to drawing 5 (a)).
[0041] To this opening and a wiring gutter, the sequential deposition (refer to drawing 5 (b)) of TiWN150 and the W wiring 160 is carried out, polish removal of TiWN outside a wiring gutter and the W is carried out by CMP after that, TiWN150 is deposited and processed, and W wiring is completely covered with TiWN (refer to drawing 5 (c)). The Si nitride 170 is deposited and W wiring is covered with TiN and Si nitride (refer to drawing 5 (d)). It heat-treats in a vacuum after wiring formation.
[0042] the 3rd example of [example 3] this invention is shown in drawing 6 -- as -- the Si oxide film 100, the lower electrode 110, the ferroelectric thin film 120, and the up electrode 130 -- respectively -- SiO2 substrate, Pt, and SrBi2(Ta, Nb) 2 -- the Si nitride 140 by which opening of right above [up electrode] was carried out to the capacity constituted using O9 and Pt is formed (refer to drawing 6 (a)). The sequential deposition of TiN150 and the W wiring 160 is carried out on this up electrode, and a wiring configuration is processed (refer to drawing 6 (b)). TiN150 is deposited and processed and W wiring is covered with TiN (refer to drawing 6 (c)).
[0043] It considers as the structure (refer to drawing 6 (d)) where deposited the Si nitride 170 and W wiring was covered with TiN and Si nitride. It heat-treats in O2 after wiring formation.
[0044] As mentioned above, degradation after wiring formation is recoverable by carrying out elevated-temperature heat treatment. That is, although it is because copper or a refractory metal was used for the wiring material, the melting point of copper and a refractory metal is 1000 degrees C or

more, therefore it is because 500-800-degree C heat treatment required for recovery of a ferroelectric can be performed. Although peeling and diffusion pose a problem when heat-treating using those wiring materials, it can prevent by using the nitride which contains Ti at least.
[0045] Moreover, if wiring is covered with Si oxide film like before, although oxidation may arise in wiring, it is avoidable by using Si nitride. Degradation after a processing process is recoverable by performing heat treatment after wiring formation. When a wiring material is copper, heat-treating in inactive or a vacuum is desirable. In inactive or a vacuum, since it is few, copper oxidation can be further prevented for oxygen tension.
[0046] Moreover, since the amount of the oxygen which diffuses Si nitride becomes less, even if it makes Si nitride thinner than the case where it is among an oxygen ambient atmosphere, it hardly oxidizes. The specific inductive capacity of ****** can be decreased by thin film-ization of Si nitride, and signal delay can be lessened.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

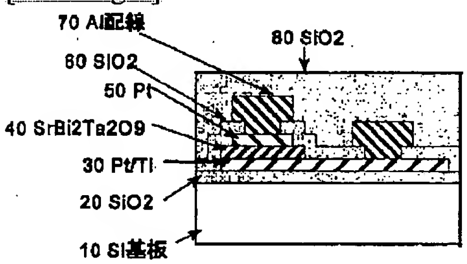
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The ** type sectional view showing the sample for explaining the technical problem of this invention.
[Drawing 2] The graphical representation for explaining the technical problem of this invention.
[Drawing 3] The graphical representation for explaining the technical problem of this invention.
[Drawing 4] The graphical representation for explaining the technical problem of this invention.
[Drawing 5] The ** type sectional view showing the sample in the gestalt and example of operation of this invention.
[Drawing 6] The ** type sectional view showing the sample in the example of this invention.
[Description of Notations]
10 90 Si substrate
20,60,80,100 SiO_2
30 Pt/Ti
40 $SrBi_2Ta_2O_9$
50 Pt
70 Aluminum Wiring
110 Lower Electrode
120 Ferroelectric Thin Film
130 Up Electrode
140,170 Si nitride
150 Nitride Which Contains Ti at Least
160 Copper or Refractory Metal

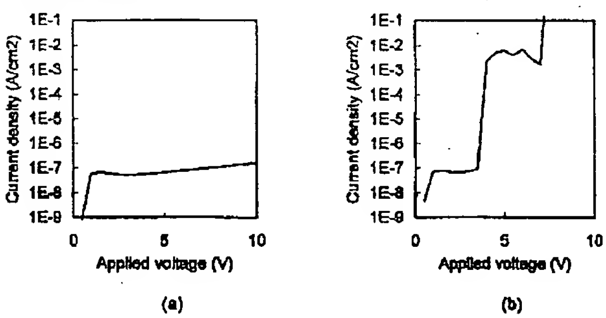
[Translation done.]

DRAWINGS

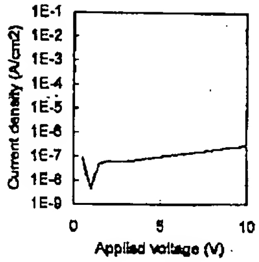
[Drawing 1]



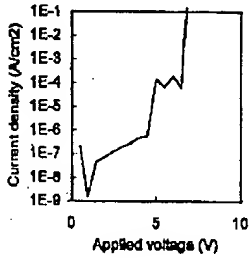
[Drawing 2]



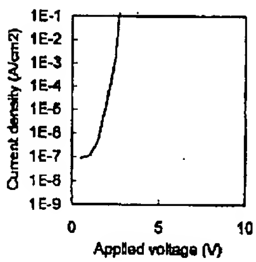
[Drawing 3]



(a) 30%

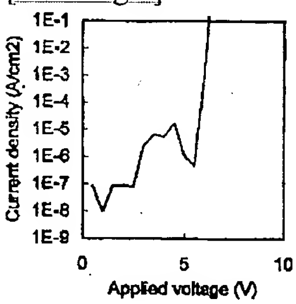


(b) 60%

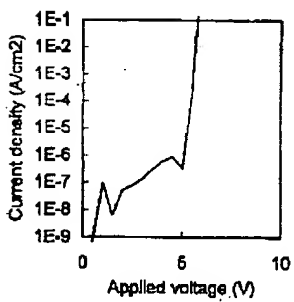


(c) 75%

[Drawing 4]

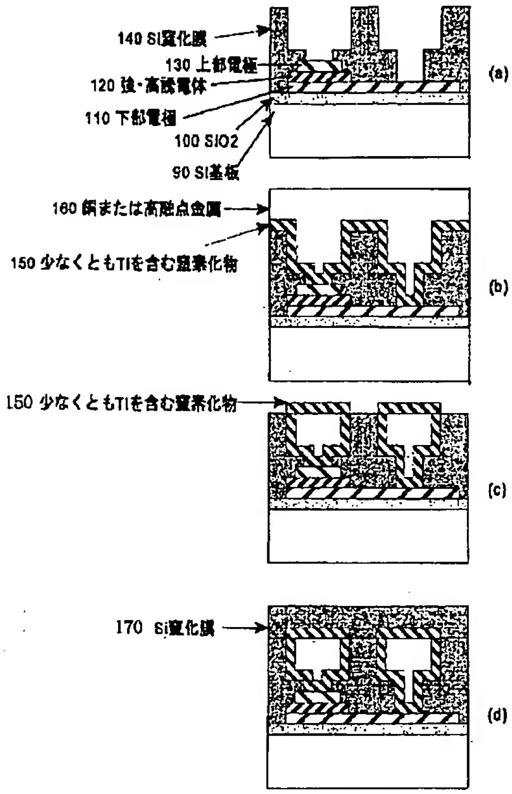


(a) as etched

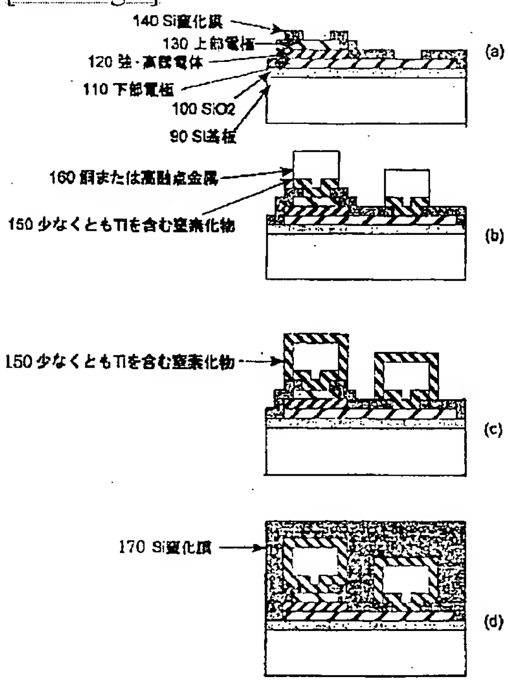


(b) after 400C annealing

[Drawing 5]



[Drawing 6]



[Translation done.]